

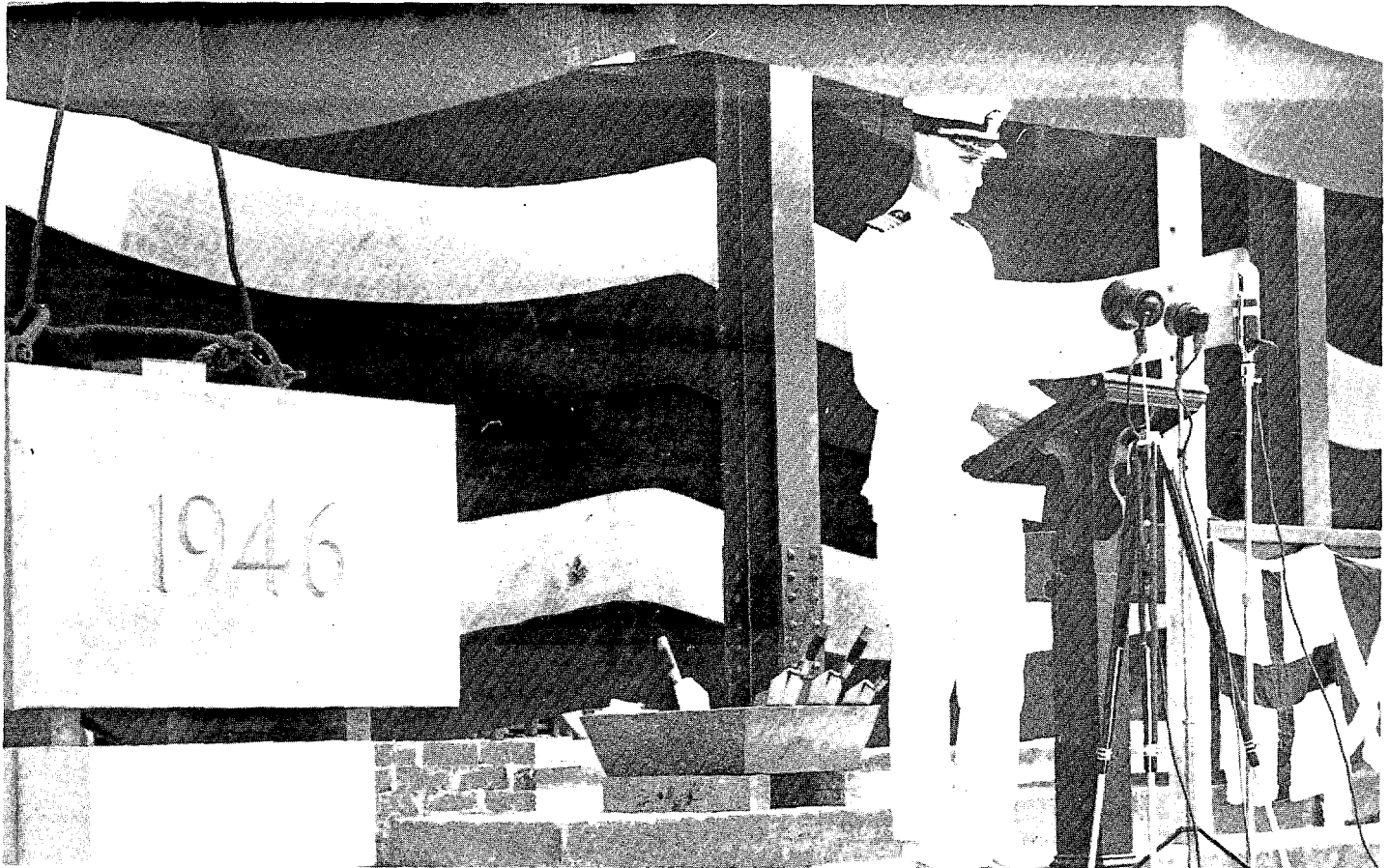
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The Bennett Years



The Development of the Modern Naval Ordnance Laboratory

Ralph D. Bennett



NAVAL SURFACE WEAPONS CENTER

Dahlgren, Virginia 22448-5000 • Silver Spring, Maryland 20903-5000

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The Bennett Years

1940-1954

This publication is a reprinted version of a historical series that originally appeared in On the Surface, the official periodical of the Naval Surface Weapons Center, during the period 9 September 1983 through 29 June 1984. Together, these articles describe the phenomenal growth of the modern Naval Ordnance Laboratory from a small shop in the Washington Navy Yard to one of the Navy's premier research and development organizations. The Naval Ordnance Laboratory was one of the two major laboratories (the other being the Naval Weapons Laboratory, Dahlgren, Va.) that were merged in 1974 to create the Naval Surface Weapons Center.

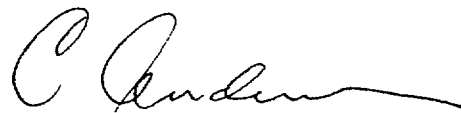
Dr. Ralph D. Bennett came to NOL in 1940 and quickly became, in succession: Head of Mine Development, Director of Technical Development, and Technical Director by 1945. He was made civilian Technical Director in 1947, retiring in 1954 to be succeeded by Dr. Gregory K. Hartmann.

Dr. Bennett was a man uniquely placed to bring about significant changes in the way the Navy handled its research and development in those early years. Having both a Captain's rank and a respected technical background, he played a major role in the development of the Military-civilian partnership at NOL, and saw its use accepted universally in the rest of the Navy's R&D management. The Navywide system of Commander/Technical Director management owes its origins to Dr. Bennett.

This publication is issued on the occasion of the Naval Surface Weapons Center's third Technology Symposium, during which the White Oak auditorium is dedicated in recognition of Dr. Bennett's accomplishments, both technical and managerial.



DR. LEMMUEL L. HILL
Technical Director



C. A. ANDERSON, Captain, USN
Commander

COVER: CAPT Ralph D. Bennett, USNR, during cornerstone-laying ceremonies for the Naval Ordnance Laboratory, 15 August 1946.

Preface: The Professor Volunteers

Ralph D. Bennett was your typical mild-mannered university professor when World War II began to develop. He received a Navy commission under a program, begun in the late 1930s, wherein the Navy began preparing itself for the increasing technical complexity of naval warfare by adding experienced technical people to the Naval Reserve. Several faculty members at Massachusetts Institute of Technology, where Dr. Bennett was teaching, were extended this offer.

One of the early developments of the war was the use of magnetic mines in ship channels. It must be emphasized that this was a severe threat; the war was over so long ago that few today realize how close the Nazis came to winning it, and their new aircraft-laid magnetic mine was one of the reasons. The Allies could not counter the thing. "I was teaching Electrical Measurements at MIT, and naturally became interested in these mines and the countermeasures the British were developing," says Dr. Bennett. "By only moderately devious means, I managed to get aboard a British freighter in Boston and examined the coils, controls, and power supply." He began forming some opinions on the subject and decided he could help. In June of 1940 he was in Washington on other business; "By that time, I believed I knew how to demagnetize a ship." With what he terms his "little-used commission" in hand, he went to the Navy Department and naively offered his services for the balance of the summer; the result could be termed

predictable. He was referred to the Bureau of Naval Ordnance, which thanked him for his offer and assured him that the Navy had all the technical officers it needed!

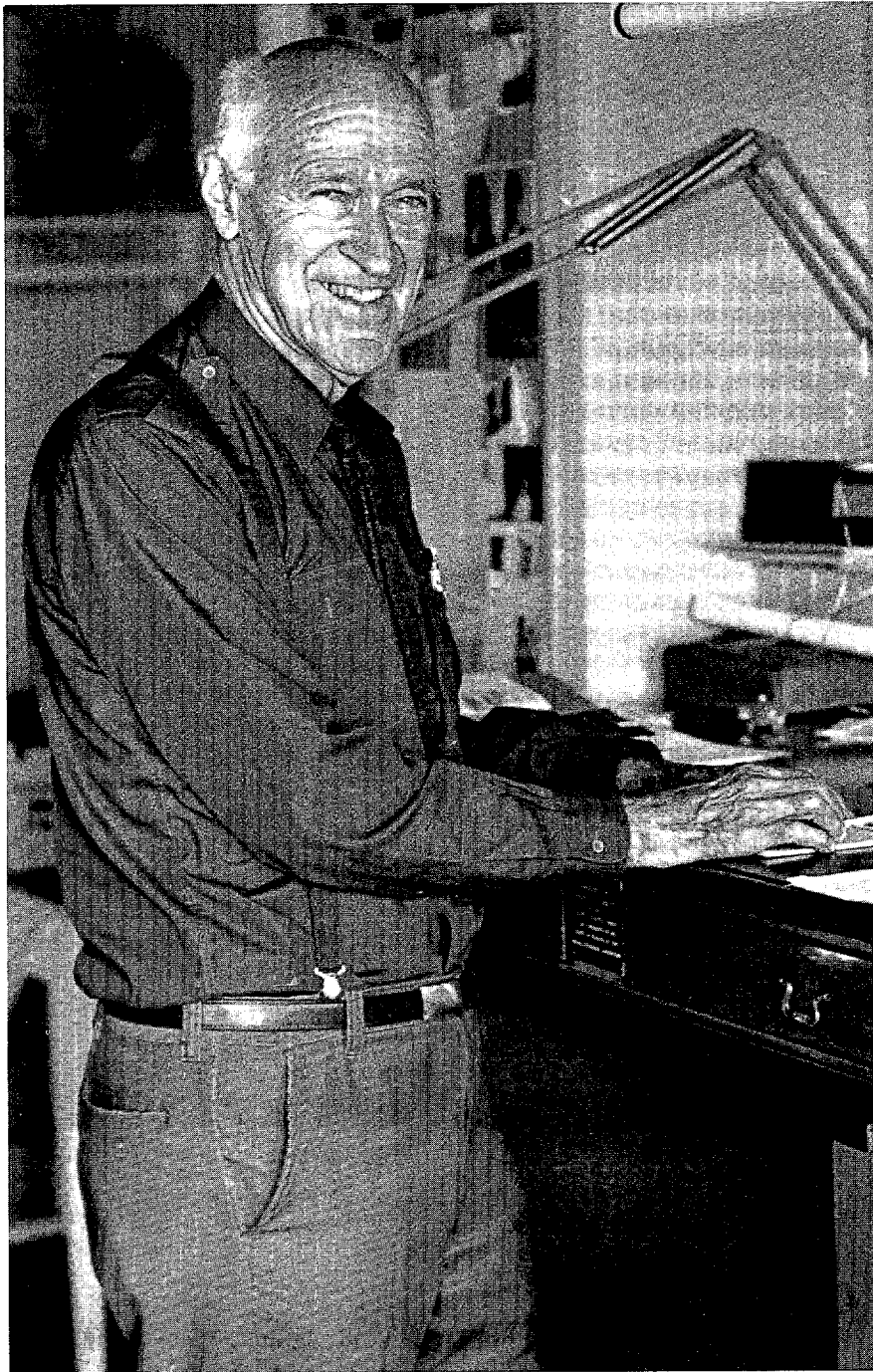
When the professor returned to Massachusetts, he casually asked the Captain in charge of the young naval officers studying at MIT, "What kind of a navy is this that I have joined the reserve of, that, faced with a world war, needs no more technical officers?"

The Captain said that he didn't know but was going to Washington that night and would find out. Somebody down on Independence Avenue must have been sizzled good, because there were telegraphic orders in Cambridge the next day ordering R.D. Bennett, LCDR USNR, to active duty for six weeks.

When the new technical officer arrived in July of 1940, he was sent to the small Naval Ordnance Laboratory, a one-lung outfit operating as a tenant at the Washington Navy Yard. His six weeks of active duty stretched to seven years, during which time the little laboratory grew, tackled increasingly complex problems, grew, solved the threat of the magnetic mines, grew, took on the mine war against Japan, grew, and began building a permanent home out in the deserted countryside of White Oak, near the two-lane highway called U.S. 29 where it came up what are now Colesville Road, Lockwood Drive, and New Hampshire Avenue toward Ashton. The story of this growth and success, the history of one of the major components of today's Naval Sur-

face Weapons Center, is to be found in several obscure documents (NOLR 1000, command histories, etc.); several books (*Mines Against Japan* (Johnson and Kutcher), *Weapons that Wait* (Hartmann), *America's Use of Sea Mines* (Duncan), etc.); and such reference works as *The History of the White Oak Laboratory* (Smaldone). But first-hand recollections of the man largely responsible for making it happen have a special value.

Dr. Bennett, now living in San Francisco, has agreed to write a few articles for *On the Surface* containing his view of these early years. After the war, he transformed the structure not only of the White Oak Laboratory but of others with the CO/TD system of laboratory management. "I claim," he admits after direct questioning, "to have invented that. Eventually it became apparent that there was a technical side to this operation that the officer corps couldn't handle. I was a Captain by that time, and had the same status as the commander of the laboratory." He had actually been the OIC for a time in 1943, while awaiting the arrival of CAPT Schindler; "By the time (RADM) Beatty came along in 1947, I got the same privileges as he did. His job was to get support from BuOrd, and my job was to run the technical operations. That gave us an organization that would attract capable people. The Navy had on its hands an NOL with 3000 people, and NOTS at Inyokern ... ADM Hussey persuaded Congress to pass Public Law 313, giving technical directors a top salary of \$15,000. Tommy



G. Hamlin

Above, a grateful Navy gave Dr. Bennett this unique stand-up desk when he left NOL in 1954. It had become his trademark during his tenure and the donors will undoubtedly be pleased to know that he still has it. "Sure, it's over here in the next room—freshly cluttered." If you knew Ralph Bennett in 1950, you would recognize him walking down the street today. Told this, he observed, "I wore out at age 30, and haven't changed since."

Thompson (NOTS China Lake) and I were appointed the first ones under that law."

Dr. Bennett, after significantly reforming the Navy's R&D community, left in 1954 for General Electric in Schenectady; was then made manager of GE's nuclear laboratory in California and stayed until 1961. "The nuclear business kinda died," he says now. "That's ominous, in my opinion; we're going to come up here in a few years to where we can burn nothing but coal." He then went to Martin/Martin-Marietta and ran their nuclear program until 1967; "They found out how old I was, so I got retired. They were getting out of the nuclear business too. Manpower and all the safety devices are making it unprofitable."

In the articles which will follow, Dr. Bennett is relying on minimal notes. "We were discouraged from keeping diaries during the war; as for records, so much of it was classified, and I moved around so much, that I don't really have any," he said. But the foundation Bennett left behind for the Naval Ordnance Laboratory and the Naval Surface Weapons Center does endure. "I've always felt," he said today, "that going down to Washington and starting this thing was the most valuable thing I ever did."



Above, the plaque affixed to Bennett's desk. Well, look, Ralph, the Navy wasn't being all that generous—nobody else except Lincoln's Secretary of War, Edwin Stanton, ever used one of these things, and nobody put in for it when you left.

I: Prewar Preparations

When France fell to the Nazis in June of 1940 it seemed clear that the United States would have to get involved in the war in Europe eventually. The United Kingdom alone could not overcome the Nazi war machine, and most thinking citizens did not believe that we should stand by while Hitler and his gang continued to take over the whole world. To counter this possibility, several operations were carried out in the United States; one of them was carried out at the Naval Ordnance Laboratory, and it was under way a year and a half before we were attacked.

Mines were then, and may still be, nobody's business in the Navy. Their uncertain status, and continuing lack of high-level understanding, interest and support are ably described in *Weapons that Wait*. It is generally admitted that a mined channel, provided the mine field can be maintained, is about as surely a block to the passage of ships of substantial size as it would be if filled with rock. However, the use of mines fails to satisfy gung-ho warriors because the miners—unlike those who use shells, bombs, and torpedoes—are not around to see and hear the big bang. As for the high-level types, their lack of long-term interest was once pithily characterized by Elmo Zumwalt: "Mines have no decks for Admirals to pace." In 1940, we found ourselves looking at the wrong end of the mine threat. The Germans had developed an air-laid magnetic-influence



Dr. Ralph Bennett during his tenure as NOL Technical Director.

mine that resisted all previous sweeping and defensive techniques, and there had been little done to solve the problem except by the British. In late June, armed with my little-used commission, some knowledge of electricity and magnetism, and a slight knowledge of magnetic mine countermeasures, I knocked on the door of the Navy Department and offered my services for the rest of the summer. I got orders for six weeks of duty, but stayed seven years; I reported on 22 July 1940.

The Navy Yard and the Mine Unit

We began work on the German magnetic mine problem at the Washington Navy Yard. It was there that John Dahlgren developed his gun, which would be fired several hundred

times without bursting. Dahlgren* had a beginning of an understanding of fatigue in metals; he learned to control fulminate of mercury; he developed reliable shells and fuzes; he demonstrated "skip shooting," which appeared again as "skip bombing" in World War II. Dahlgren shot his guns down the Anacostia from the Navy Yard waterfront until the range became too short and the area too densely populated; the work was then moved to Indian Head.

By 1940 the name Naval Ordnance Laboratory was of recent origin. The laboratory was composed of a Mine Unit and an Ammunition Unit, the latter a direct descendent of Dahlgren's. The Ammunition Unit's work had been transferred back to the Navy Yard when the Indian Head range became too short and the range at Dahlgren was established, thus laying the foundation for what was to become the Navy's largest R&D Center in 1974 when all these activities were recombined. As for the Mine Unit, that was the child of a joint effort by the UK and the US, which built the North Sea Mine Barrage in World War I. The Mine Building in the Navy Yard was a part of that effort and in 1940 housed both Units under CDR James Glennon as OIC. The resident genius of the Ammunition Unit was Ray Grauman, who was an expert in explosive trains and whose best-known achievement was the redesign of a British anti-aircraft fuze

*Dahlgren reports in his diary that he had troubles getting things through the Bureau of Ordnance. So did we, a century later.

for American manufacture, saving hundreds of millions of dollars. In the area of mines, the resident genius was Robert Duncan, senior scientist.

Duncan was a hero on several counts. During the depression years he held a small group of professional people together, keeping them working and doing good with almost vanishing financial support. There was a continuing effort toward improving the Mark 6 mine, and even a limited effort toward an influence firing device.

Expenditures for technical supplies were limited, to as low as \$5 a week. The sort of ingenuity this called for is best illustrated by the time Duncan needed a fractional horsepower motor. He bought the rotor and the stator on separate stubs—and informed the supplier that the government would accept the two items assembled.

Duncan fitted his conduct and performance to the needs and desires of his military supervisors; he achieved and generated a top-level job in a small and rather obscure operation, and made an effort to keep up with what was happening in physics. All this was about to change; and when we outsiders began piling aboard, enlarging his staff by a factor of about 200, Duncan never relaxed his efforts or showed concern that the leadership inevitably changed, eclipsing his position. Because of his knowledge and experience, our work was more effective and our progress more rapid. He knew red tape and how to cut it. As we grew to an overwhelmingly large organization, he continued to help.

Go measure something

By 1940 Duncan was getting more support, and had a working crew; his

assistant, Wilson Maltby, and engineers Albert Sellman and Clifford Vogt. From the Department of Terrestrial Magnetism of the Carnegie Institution of Washington came Ellis Johnson, who had by coincidence recently finished his PhD thesis project under me at MIT. Ellis realized that the first thing to do was to measure the magnetic fields of some ships to find the magnitude of these fields. He had chosen to build eight coils of heavy wire to place on the bottom, properly lined up relative to the earth's field, and pass ships over them. To the coils he connected fluxmeters, which have the movement of a D'Arsonval galvanometer but without a restoring force on the coil. If connected to a coil of zero resistance, the fluxmeter coil will attempt to move in such a way as to keep the total flux linkages in the system constant; knowing the dimensions of the coils on the bottom, and the number of turns of wire, the change in field strength can be calculated. We could not get bottom coils of zero resistance, but with brass frames six feet or so in diameter, wound with about a hundred turns of stranded insulated copper wire about $\frac{3}{8}$ inch in diameter, we came close enough! The shop at the laboratory, about half a hundred true artisans, made up the frames and wound them very quickly, while General Electric got the fluxmeters to us in a few days. We built a gimbal arrangement on the

fantail of our fleet—one USS *Cormorant*—and we were ready to go down to the Bay and measure some ships. We went down the Potomac on our overage World-War-I minelayer, passing under the new high bridge at Dahlgren while sleeping out on deck under the stars.**

On arrival at Plantation Flats, a large area of the Bay whose depth is very uniform at between 40 and 50 feet, we wasted a day trying to get poor *Cormorant* to do the impossible for a single-screw vessel a couple of decades before bow thrusters. To the rescue came the Coast Guard, whose Commandant sent over a cutter with the rather unlikely name of *Pansy*. Her captain was not one to fool around. Declining a boat to transfer to *Cormorant*, he brought *Pansy* to within a foot and stepped aboard; after a brief discussion and the transfer of the coils, he had our hardware on the bottom in line and was on his way. I have admired the Coast Guard ever since. We radioed headquarters that we were connected up and working; send us some ships.

The next morning we had a ship: the newest battleship, just commissioned. USS *Washington*, all 40,000 tons of her, brand new and shining, made several passes over our string of coils. Ellis managed the fluxmeters on *Cormorant's* fantail. The results were heartening, because they showed we could do it—but they were also sobering. *Washington* was only an early piece of the "Two-Ocean" Navy our country had decided to build, and the five-merchant-ships-a-day program had not yet gotten well under way. The size of the task before us was, we realized, immense. We began planning an organization for our little lab that might get the necessary R&D done in time.

**Sleeping out under the stars did not last long. The Captain discovered that I was acting not only as a helper to Ellis but as an officer on active duty and of his own rank! Nothing would do but that I move to the lower bunk in the officers' quarters, making it necessary for Ellis to move to the upper one. This was my first encounter with RHIP—"Rank Hath Its Privileges."

II: To Build A Laboratory

Originally, of course, the Naval Ordnance Laboratory was a small wart on the side of the Naval Gun Factory with its 5,000 employees. It was easy to overlook NOL for many years, but with the coming of war in 1940-41 that all changed. We used the same services as the rest of the Gun Factory, and gave them trouble all beyond our size and expenditure levels.

Assembling a staff

By mid-August of 1940, with the magnetic measurement of USS *Washington* behind us and with my one month on the job, we could see that we would need more people. There were hundreds of ships on hand and hundreds more being built. So we went to **CDR Glennon** with a plan to enlarge the laboratory staff as quickly as possible; we suggested adding 64 physicists, mathematicians, and engineers. The Commander was aghast and informed us that he would not stand for such empire building, but he did agree to let us hire 20. We decided to organize a recruiting trip through the East and Midwest and, partly because of my acquaintance with several physicists in those areas, I was elected to be the recruiter. It was early September; the school year was just starting, and the faculties would be back from their summer activities. I planned to spend about a week, visiting as many universities as I could, getting names of graduates and faculty. In the meantime **Ellis Johnson**, who had good connections

at Minnesota, had persuaded **Lynn Rumbaugh** to join us, and others followed later; **John Bardeen** was perhaps the best known of the Minnesota recruits.

My odyssey included Pitt, freshly ensconced in its innovative and non-ivory tower; Carnegie Tech (now part of Carnegie-Mellon), Case (now part of Case Western Reserve), Michigan, Chicago, Armor Tech, Northwestern, Wisconsin, Washington (St. Louis), Ohio State.

Present-day travelers might take note of the fact that this trip, except for the Chicago-St. Louis segment (my first commercial air trip) and the overnight boat ride from Cleveland to Detroit, was made by train. Legendary and romantic names like Wabash, Hiawatha, and Nellie Bly made up railroading then. I doubt that I could have made my university visits in much less time in the airplane age, then or now; travel then for short distances such as these, with fast trains and frequent schedules on several railroads, was more convenient. The trains usually took you where you wanted to go, rather than a score of miles out in the prairie. Present-day travelers might also note that the travel allowance was five dollars a day for room and board, although by 1941 Congress was thinking of raising it to six and did so; coach travel was two cents a mile, and in uniform and on leave it was one cent.

We managed.

The recruiting trip was highly successful. We found our twenty, and a lot of leads; and as 1940 gave way to

1941 the original limit was forgotten. From Wisconsin came **Gregory Breit**, and from Ohio State came **Royal Weller** and **George Shortley**. From Iowa State came **John Atanasoff**, fresh from inventing the digital computer. The ten-strike was getting in touch with **Professor A. D. Moore** in Ann Arbor, because he had for some time been involved in the administration of the Electrical Engineering honorary society Tau Beta Pi. He had contact with the best of recent E.E. graduates, and before long served us well as a recruiter, bringing us many able young electrical engineers.

The chain of acquaintances and recruiting eventually led us to **Robert Moore**, Director of Placement at Columbia and widely acquainted in American industry, who undertook a nationwide search for talented people. His quest uncovered an excellent source: oil companies, whose foreign exploration work had been curtailed by the spread of war. Among the people he was able to interest were **Noyes Smith**, **Darrel Hughes**, **Roy Pasley**, **Ralph Hightower**, **Whitney Mounce**, and **Dave Muzzey**, all scientifically trained and most of them experienced in field measurements of many kinds.

At NOL we had a recruiting asset: a defined Navy problem whose solution would meet an immediate need. By better luck than we knew at the time, we had the means of assembling a group quickly. We could offer a personal services contract to anyone we recommended—so long as he did not require more than \$20 a day in

“... At our maximum dispersal we had work going on in 13 buildings. Eventually, of course, came a general edict: no more buildings! However, we were permitted to have additions to existing ones. Thus one of the buildings across the river slowly took on a comic appearance. Its first addition was larger than the original building—but the second addition was larger than the first one.”



The Navy Mine Building as it looked circa 1948.

wages. “Fringes” had not yet become important, and nobody was worrying about a pension. There was no insurance, and no allowance for travel to Washington. The going rate for a B.S. with little experience was \$7 a day.

Growing pains

It was not long before we became a problem to the Supply Department. That department, at the Gun Factory, was organized to buy big things in large quantities, ordered with reasonable foresight and costing great sums. Our experimental work required little things, one or a few at a time, and “tomorrow please, if you can’t get it today.” This was especially true of electronic items at that time, a new kind of thing in the Gun Factory. That particular problem was eventually solved by a “help yourself” store-room—which took some doing in a government operation, and would not be feasible today in that form. By the time we had built up to full strength, we made $\frac{3}{4}$ of the work of the Supply Department.

Then, of course, there was Public Works. We called on those overworked people as we grew, always for more and more space, first enlarging the Mine Building and then erecting a much larger building next door. We squeezed into other areas that could be made available, and eventually got a number of temporary buildings across the Anacostia. At our maximum dispersal we had work going in 13 buildings. Eventually, of course, came a general edict: no more buildings! However, we were permitted to have additions to existing ones. Thus one of the buildings across the river slowly took on a comic appearance, and a photograph eludes me. Its first addition was larger than the original building—and the second addition was larger than the first one.

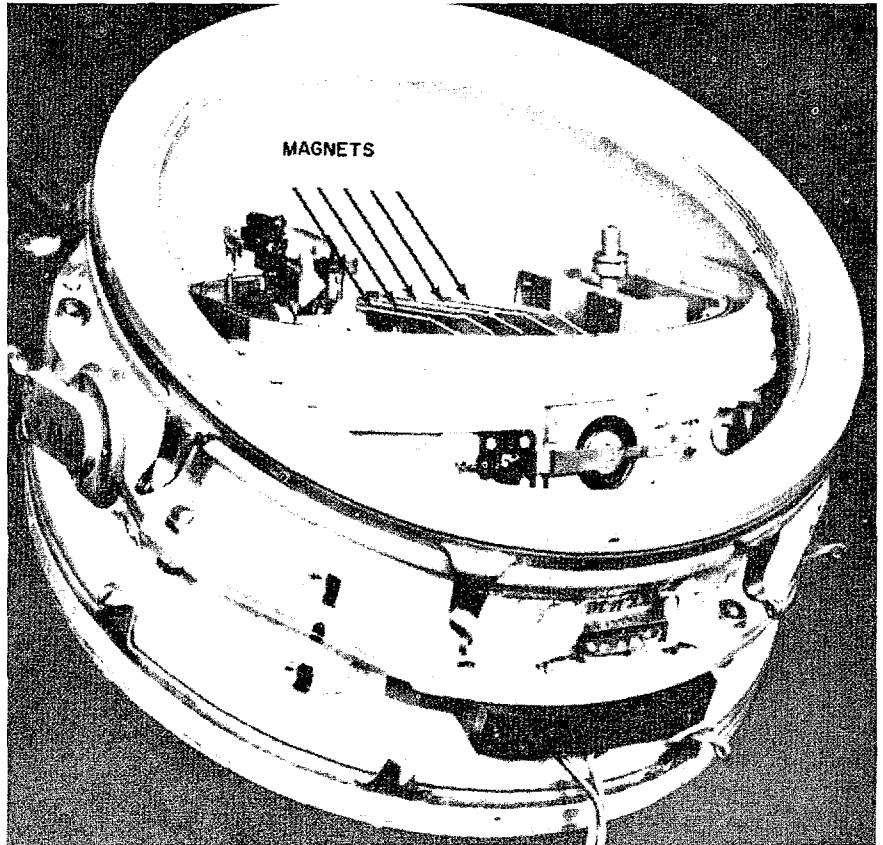
With an able staff and enough equipment, it wasn’t long before we began to produce some results.

III: NOL Begins to Contribute

With a staff assembled, and buildings growing everywhere, our little laboratory could begin to do things at last. Our first and foremost objective in the summer of 1940 was defense against magnetic mines; without such, there would be important limitations on the mobility of our fleet and merchant marine. Our principal effort was aimed at reducing the magnetic fields of ships and, with the help of the British, we were acquiring an understanding of the technology involved. But we were not going to win the war with defensive measures alone.

We go offensive

Professor/LCDR **Francis Bitter** (the expert on magnetism from MIT), Professor **Shirley Quimby** of Columbia, **LT Kenneth Veth**, **LCDR "Muddy" Waters**, and **LT "Moe" Archer** were in the UK sending us information. Among the treasures they sent back was a firing device from a German magnetic mine, which had been laid in shallow English waters and disarmed. We had nothing like it. Because all is fair in love and war, we decided to copy it, and never mind pride of authorship. Among our early recruits was **Robert Park**, an E.E. from MIT who was working at American Cyanamid. Bob borrowed a mechanical designer from Cyanamid and went to work. Remember, there was a national emergency going on; there was never any worry about who was going to pay for things of this nature. Cyanamid contributed the serv-



Early German magnetic mine firing device.

ices. In walked **CDR Glennon** on Monday morning and there was this stranger working on the firing device with calipers, scales and sketchbook. Clearance techniques had not yet reached full flower; we told the skipper it was all right.

The German firing device was of the dipping needle type, with several parallel needles to increase its sensitivity to field changes caused by ship passage. The magnetic assembly was supported on gimbals but clamped

firmly until the mine had undergone water impact and bottom shock, and a balancing mechanism had brought the needles to a horizontal position after the mine came to rest. To go with the firing device we would need a mine and a means of delivery. The resulting mine was the Mk12.

Designing and producing a mine that could be laid by air or submarine now moved to first priority; the first production quantity was to be 3,000. The material chosen was alumi-

num—a new venture in mine cases for our Navy. The dimensions were dictated by the size of torpedo tubes, and it needed fittings for torpedo launching or air launching. Because of the delicacy of the firing device, we decided to deliver it from the air by parachute. Parachute designers were called in and asked to enlarge their concepts from those capable of delivering a human to something for half a ton. By this time, Bob Park had become what would now be called the project manager, involving not only NOL but the Bureau and a considerable part of US industry. The skill and energy with which all involved performed were demonstrated by the fact that we had the first shipment of mines out in the field in sufficient quantity and on time. It was not a particularly good time, or location. The mines were delivered to Cavite (Philippines) and Pearl Harbor, and a group of engineers was on the way to prepare them for laying. On 7 December 1941.

Hickam Field was under attack as they approached Hawaii; they landed on Hilo and never got to Cavite. The mines at Cavite were, I think, jettisoned, while those at Pearl were used later, together with the rest of the production, in the mining of channels in Japan's newly but temporarily acquired empire. Had the mines at Cavite been used, the Japanese approach to Manila would have been much more costly.

NOLer solves a torpedo problem

On 8 December 1941 our submarines began a torpedo campaign against Japanese shipping, which was plentiful because the enemy expanded his occupation to most of eastern Asia and began hauling home useful equipment and products from the conquered territories. Our submarines fired their torpedoes at these targets but with little success. The assumption was that the torpedoes were

missing. The skippers were accused of taking poor aim; of setting the depth too deep; of failing to approach close enough. The criticism was severe, and doubly painful because the submariners were out there risking, and sometimes losing, their lives trying to do their job well.

US torpedo development had been held very closely by a small group at the Naval Torpedo Station in Newport. Conditions in the torpedo program were not right for success. The members of the torpedo group were short of money, and their connections with modern technology were as a result limited. Furthermore, the high command of the Navy did not insist on an adequate testing program. Skippers were unwilling to risk losing any of these scarce, expensive torpedoes in practice; few had been fired at real targets. Common procedure was to aim low so the practice torpedo would pass harmlessly below the target, be recovered, and be used for "practice" again.

Ellis Johnson, always interested in being where the action was, went out to Pearl in November 1942 and talked with many people. As a result, he



arranged to have a torpedo, with a plaster-loaded warhead, hoisted up to a height that would, on release, give it speed equal to that of a running torpedo. He then dropped it on solid rock. The autopsy revealed the problem.

The firing device of this torpedo was a percussion cap struck by a striker mounted on a brass rod, propelled crosswise of the torpedo by a spring and guided by a surrounding brass tube. Impact with the rock deformed the guide tube enough to stop the striker short of the percussion cap. With such a design, it was more the exception than the rule for a torpedo to detonate, because there are many solid places on a ship. Ellis' solution was to turn down the central part of the rod to reduce its mass without impairing its guidance function; this enabled the driving spring to move the striker all the way to the cap before the tube deformed. The problem was not the users; it was the design. Ellis' simple test solved the problem and the submarine campaign soon reached the expected level of success. This test became one of the arguments for making federal service,

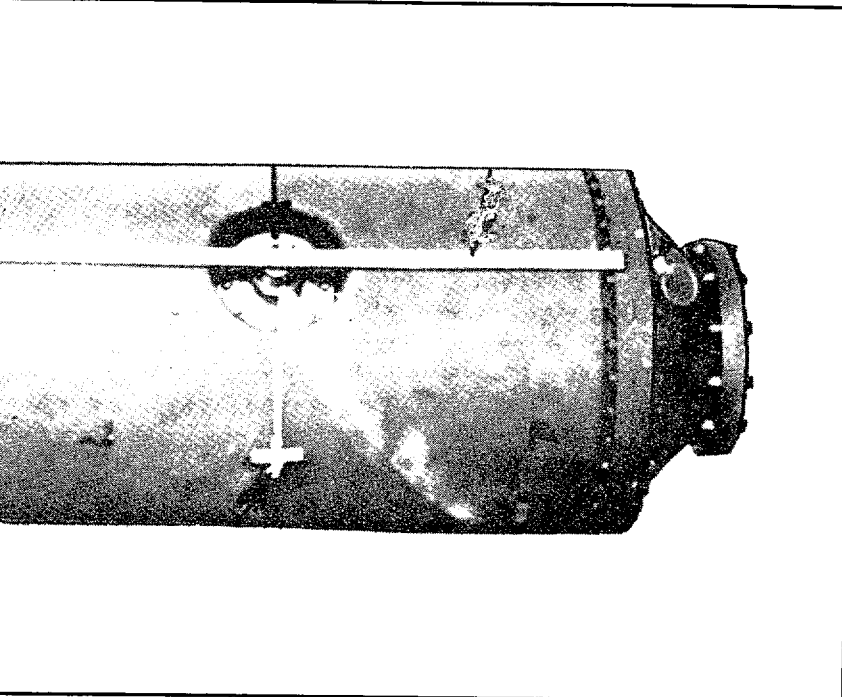
especially with the Navy, more attractive to technical people, so as to have someone around with curiosity and armed with the authority to put it to use.

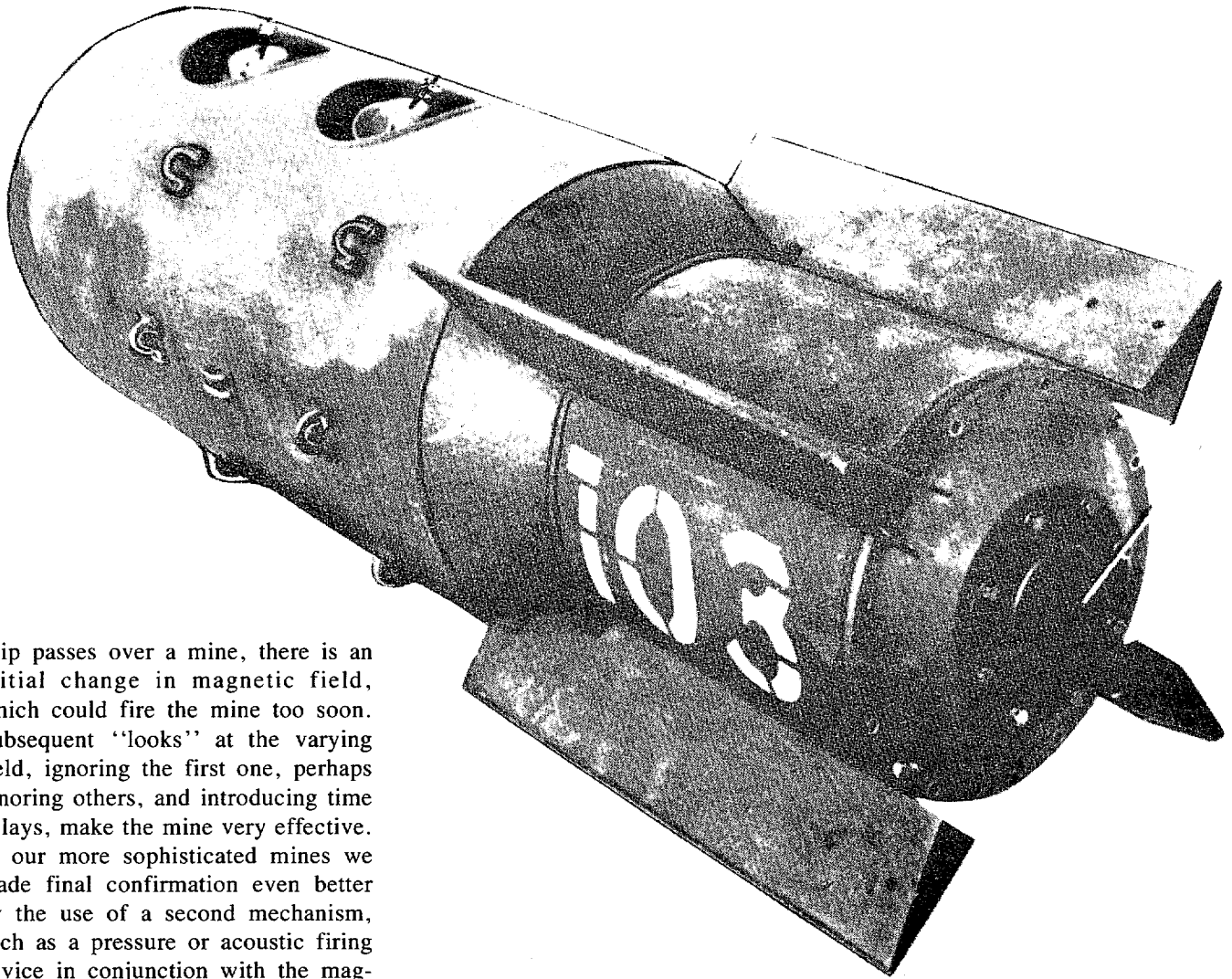
Our very own mine design

While Bob Park was Americanizing the dip-needle German mine design and getting it into production, we undertook the design of our own firing device. The German device was delicate and expensive; we wanted a more rugged weapon. To this task we assigned **Ed Gilfillan**, who had recently joined us and had a reputation for ingenuity; and to help him we assigned **Seymour Sindeband**. We had recruited Sindy from Consolidated Edison; it wasn't easy, because a long-distance telephone call required permission from the Commandant of the Navy Yard. He turned out to have NROTC experience and a rank of Probationary Ensign, which made it possible to bring him to Washington. Sindy was unique in vision, versatility, and accomplishment, and helped this project immediately; the outcome was the permalloy core coil and relay arrangement which in various forms became the fundamental concept for many of our mines. Sindy is one of the inventors listed on the patent. The permalloy rod was about a yard long, wound with a coil of copper wire connected to a sensitive relay. Amplification was necessary to fire the mine, and was achieved by different methods in different mines. When vacuum-tube amplifiers were used, the life of the batteries limited the active life of the mine.*

By this time we were becoming very knowledgeable about the magnetic fields of ships, so we had a good idea of what had to be done to cause the mine to fire at the right position to do maximum damage. As the

This, of course, was before ex-NOLer **John Bardeen helped invent the transistor.*



Prototype Navy Mine Mk 13.

ship passes over a mine, there is an initial change in magnetic field, which could fire the mine too soon. Subsequent "looks" at the varying field, ignoring the first one, perhaps ignoring others, and introducing time delays, make the mine very effective. In our more sophisticated mines we made final confirmation even better by the use of a second mechanism, such as a pressure or acoustic firing device in conjunction with the magnetic one.

The Mk 13, our first design, carried 1000 pounds of explosive and could be dropped from 200 feet at 150 knots, yet have a good chance of remaining operative. The Mk 13 did limited but useful service early in the war in a simple configuration; and from it, better and more sophisticated mines were developed.

The pressure mine appears

The Research Division had a Special Projects Section, presided over by **Joseph Keithley**, then a recent student of mine at MIT. The name is

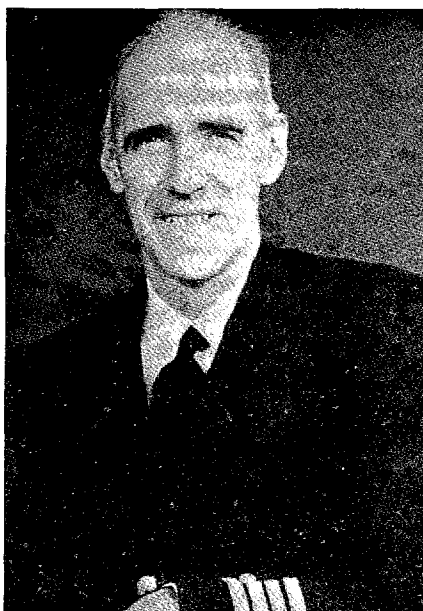
familiar to users of electrical instruments. His group set about perfecting a firing device actuated by small pressure changes under a moving ship. We suspected that such a device would produce an unsweepable mine and, therefore, made strenuous efforts to keep it hidden; the Navy had a firm principle that it would lay no mines it could not sweep. The use of the pressure mine was delayed nearly three years on this account; the time was used in perfecting and testing the device. By the time it could be used we had a versatile, reliable, and well-tested design.

It was possible to circumvent the ban on unsweepables by developing a sterilizer, which could inactivate a mine by a certain date. A clock was used; it offered reliability and the advantage of also serving as a delayed arming mechanism. There was some use of mines with sterilizers as time went on, but we found the Germans also had a pressure mine (also held very closely until used against the Normandy invasion). They used a pressure mine to sink the destroyer *Glennon*, named for the father of our 1940 OIC. We were going to have to start working on countermeasures.

IV: Awaiting Orders

By early 1942 the whole country had heard about the war; we were officially in it; and at the Navy Yard we had a substantial work force of very talented people.* We had accepted the UK's knowledge of ship's magnetism and added to it. We had helped design ranges for measuring the magnetic fields of ships, and improved the measuring devices. We were measuring other ships' influences and trying to design firing mechanisms based on them. We had the Mk 12 and Mk 13 mines in production. The time had come when we needed more guidance from the operating forces as to what could and should . . . and what would be used. But direction from above proved to be hard to get.

The Naval Districts Division of the CNO's office had cognizance over base defense; and moored mines, which were the only kind we had, were a factor in base defense. But the influence feature that we were working on made mines offensive rather than defensive weapons; and no organization existed to handle mines as offensive weapons. This development cause organizational confusion for about two years, and greatly hindered our ability to get the guidance we needed. The problem was solved (to some extent) when there were enough officers available with real knowledge of influence mines and what they could do, and much of their know-how was acquired at NOL. People in high places failed to recognize that an



LCDR Ralph Bennett, USNR, became CAPT Bennett by war's end and ran the technical side of the laboratory while the regular Navy types ran the military side.

influence mine laid by airplane was a new and powerful weapon, especially against an island nation. We were going to have to find our own way for a while.

Some NOL Contributions

One of the first things we did to make our output more useful was to establish a Degaussing Materials Division, ably managed by **John Kraus**, who came to us from the University of Michigan. The division

supplied equipment and information for those building degaussing stations, and took care of supplying and maintaining equipment required by the ranges.

To expedite the design of degaussing coils, we developed a method using scale models made of the same steel as planned for the ship. The models, with their degaussing coils, were tested in fields provided by large Helmholtz coils, by which the earth's field could be neutralized and the model's degaussing-coil fields could be measured. A field could also be applied to match that encountered in any part of the world on any heading. Models were constructed for most of the naval and merchant ships that were being planned.

Our experience in putting our copy of the German magnetic mine into service taught us abruptly that sending a couple of engineers or scientists to make sure that the weapons were properly prepared would never do if the product became popular. We would soon run out of technical people—and besides, they might not arrive. The answer of course was adequate instruction manuals. The manuals were usually treated as afterthoughts in weapon design, and the results showed it; at NOL we developed the technical manual, and an organization to produce them, to a level unique in the services.

To accompany the improved manuals, we wanted improved procedures. A scientist with a voltmeter, a bicycle pump, and a pressure gauge could test the circuits and pressure safety devices, but something which included

*They proved this not only at NOL but by the numbers of them who later became heads of corporations, famous inventors, and renowned scientists.

"We went out on the Chesapeake with a Liberty ship, and we took a lot of brass down to observe the test. An inert torpedo was fired at the ship—and the (anti-torpedo) device worked fine, that is, it did explode. But the ship took such a jolt that an enormous amount of soot was shaken loose from the boilers and the stack, and all the brass was covered from top to toe—with varying intensity according to who was windward and who was leeward..."

all the measuring equipment in easily usable and readily portable form would expedite the preparation of weapons in the field. We began designing test sets.

We also had to face the necessity of training newcomers in the general nature of the work we were doing, and in the specific details of ordnance on which they were to work. There were also officers to be trained who would be responsible for handling the ordnance in the field. So we set up a mine school. These schools, first at NOL and later at the Mine Depot in Yorktown, became very important as mines eventually went out by the thousands. **Ensign Sindeband** (who was promoted rapidly) became the leading figure in the training program.

One of our serious problems was getting an aircraft-laid mine into the water and on the bottom with its firing mechanism intact. Water and bottom impact had to be measured and simulated in the laboratory. We wanted something more sophisticated than the accepted shock-testing technique of the time: mounting the test object on a platform and hitting the platform with a big mallet.

One of our more interesting "shockers" used a smooth-bore gun barrel, with the test object mounted on a piston that could be released me-

chanically. Air pressure behind the piston determined the initial acceleration, and the volume of the air determined the duration. Air in the barrel ahead of the piston determined deceleration. **Roy Weller** was instrumental in reducing shock to a science, and **Don Marlowe**, one of our young geniuses, did much to advance this science.

Very early in NOL's expansion, **Ellis Johnson** organized a seminar of the best thinkers he could find in our group and others involved in the war effort. Their study was aimed at the offensive use of mines. This group, which included **George Shortley**, **LCDR Kenneth Veth**, **Shirley Quimby**, **Francis Bitter**, **Thornton Page**, and varied others as the war progressed, met more or less regularly and considered mines, enemy ship traffic, channels, aerial access, enemy sweeping capabilities, sterili-

zation, and arming devices. It was fortunate that Ellis did this, because nowhere else in the Navy was any such planning being done early in the war.

Progress was not always smooth—they came to the attention of security forces, for example, when they sought information on Japanese ship traffic, and were directed to stay away from classified information but allowed to continue "on their own time." This restriction didn't last long.** The Operations Research seminar was one of the many ways of getting the Navy familiar with mines, and the calculations they had made proved very useful in the final saturation mine assault on Japan.

Among these unique contributions and success stories, of course, there were a few ideas that didn't quite, ah, work out the way we planned.

**We were all inexperienced at dealing with classified information, and the tendency was always to make it SECRET if in doubt. But that didn't mean that reasonably intelligent scientists couldn't figure things out. When the big bomb folks came around to find out how to let their mysterious new item down slowly by parachute, we were able to help them, because we had developed a 1-ton size to the point of good performance. Some of our people went so far as to ask them if they had enough U-235, knowing how much they would need. Our physicists read the same technical journals they did! They were properly aghast; I am sure they would have liked to stamp us all SECRET too.

Better Luck Next Time

The US had made attempts to develop a sweep for the pressure mine. One device, nicknamed "cube steak," used barges (at the probable cost of one barge per swept mine, plus a blocked channel). It was rejected early.

Another was called "egg crate" because it resembled one; when dragged through the water it produced the necessary pressure change and might require only repair after a successful sweep. However, a tug big enough to pull the crate would probably fire the mine.

Enter **John Atanasoff** from Iowa State, one of our best idea men, and the "Loch Ness Monster." John came up with a nylon canvas bag about 30 feet in diameter and a couple of hundred feet long. It was open at the front so that, when towed, it filled with water. It produced the necessary pressure drop when pulled by a tug of reasonable size. It could also be patched if torn by a mine explosion. However, it turned out to be too difficult to maneuver in narrow channels—and besides, it used enough nylon to supply all the WAVES for life.

We had established a successful field station in Nova Scotia, and it has been described in the 1983 Year-End Ceremony and in the issue of *OTS*, not to mention a correspondence exchange which promises to see us through the next Technical Director. When we later took over the Sol-

"Among these unique contributions and success stories, of course, there were a few ideas that didn't quite, ah, work out the way we planned ..."

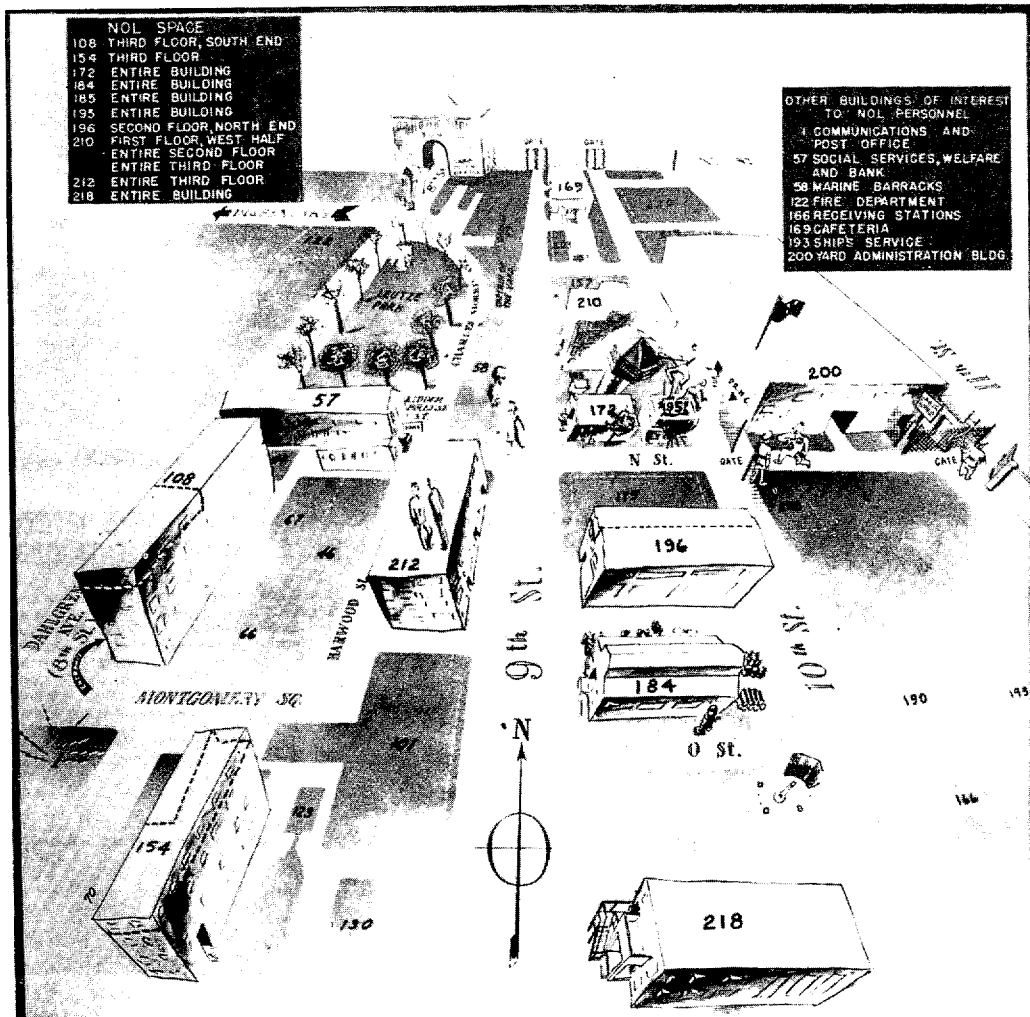
omons Island area, we found that it had a 300-foot-deep pond very close to the shore, and protected from the waves of the Chesapeake Bay. When later we became interested in the magnetic fields of submarines, we attempted to have an obsolete sub placed in this hole, halfway between the surface and the bottom. It was to be held down by large concrete block anchors fore and aft, and held up by limited buoyancy controlled from the surface. The old submarine was moved into place and let down. Something went wrong with the buoyancy control and the boat went to the bottom, where she lies to this day.

The Navy had a magnetic torpedo exploder in 1940, but it had been kept so secret that its electronics were out of date and it had never been adequately tested. It tended to premature, or fail, much too often to be usable. We had a try at improving it, but found that it was not easy. The torpedo gives the exploder a rough ride at best. A simple magnetic detector will not serve because of the motions involved, and one has to resort to a gradient or a total field device and so get small range. Adequate testing is

sure to take a long time, and each test tends to be very expensive. We went, essentially, nowhere. Work on the exploder lost priority when German submarines got scarce.

And finally, there was the famous Anti-Torpedo Device. One of our people—whom I won't name, because I don't know if he'd prefer his name attached to the idea or kept away from it—came up with the idea of towing two streamers, one on each side of a ship, hitched to the bow by a paravane. That's a sort of underwater kite, which tends to pull out in response to forward motion. Each streamer was a firehose full of TNT, equipped with acoustic listening devices, and each was maybe 50 feet from the side. When a torpedo went under the streamer, the Doppler effect of the frequency change would fire the hose, detonating the torpedo a safe distance from the ship.

So on one historic afternoon in fairly cold weather we went out on the Chesapeake with a Liberty ship, and we took a lot of brass down to observe the test. An inert torpedo was fired at the ship—and the device worked fine, that is, it did



NOL's theater of operations in the Washington Navy Yard, circa 1945.

explode. But the ship took such a jolt that an enormous amount of soot was shaken loose from the boilers and the stack, and all the brass was covered from top to toe—with varying intensity according to who was windward and who was leeward. All the uniforms needed extensive cleaning. And although the ship was not disabled, we found that the shock had cracked all the bearings on the main shaft. As if that political setback were not enough, it developed that the device was one thing on a calm day on the Chesapeake, but another at sea! Deploying the thing was a terrible struggle; the hose was getting under the ship, getting tangled with the propeller. We never sank one of our

ships but that was more good luck than good management. Fortunately, the British were sinking submarines fairly fast by then and, as with the magnetic torpedo exploder, the pressure was off this particular area of warfare soon enough.

We had a big party to celebrate when we abandoned the effort on that thing.

And yet we learned another thing from it: there weren't enough officers on hand at the Lab with the sea experience that could have warned us of some of the practical problems this device would face. It was something we tried to keep in mind as we grew.

V: Victory--and Those Who Made It Possible

By the beginning of 1944 we had spent a long 3½ years on our major objective: providing the Navy with designs of proven modern mines. There were magnetic, acoustic, and pressure firing mechanisms, usable singly and in combination; and there had been small-scale use of mines as they had developed and our forces worked their way north in the Pacific.

Action

Submarines were the first to lay our new mines, taking small numbers along on their torpedo-armed cruises hunting enemy ships. Submarine skippers were at first understandably reluctant to give up torpedo space to mines; but as their effectiveness became better known, the submarines made enemy harbors and anchorages dangerous for Japanese shipping for many months, even penetrating to the fringes of the home islands.

By March 1943 there were officers, trained by **Ellis Johnson's** operations seminars, to qualify as staff mining officers to the commanders in the principal Pacific operating areas. **LT Kenneth Veth** went to the China-Burma-India theater, **LCDR (Professor) Shirley Quimby** to the southwestern Pacific theater, and **LCDR (scientist) Ellis Johnson** to the central Pacific theater. Our test work had shown which of our designs would be useful, and production of these was being stepped up. Advanced depots were being set up.

Men and officers were being trained at **NOL** and **Yorktown** in the preparation of mines for laying, and such field adjustments as might be required.

LT Veth served under a British area commander in the **C-B-I** theater, who knew about mines and their usefulness. There were both British and American mines, and British and American planes—a complicated situation which **Veth** managed well. Mining of enemy harbors took place extensively, forcing the enemy to abandon them one by one, severely limiting his ability to take home loot from areas he had taken over, and interfering seriously with the replenishment of materials and manpower in his advanced bases.

LCDR Quimby served an American commanding officer who knew little about mines, and apparently cared even less. He believed only in bombs. He had both American and Australian planes, but assigned American planes to mining only when there were no bombing targets; so most of the mines used in this theater were laid by Australian planes. Even in limited numbers they proved a useful harassment to the enemy by blocking harbors and closing protected passages, thus forcing traffic out into the open where ships were better targets.

In the central Pacific theater **Ellis Johnson** served as mining officer to various commanders, including both **Admiral Nimitz** and **General LeMay**. In this area a carrier force mined the exits of the lagoon of **Palau**, trapping 32 ships. All were sunk in place by

bombs or torpedos or mined attempting to exit. This was one of the few mining attacks carried out by carrier planes, and the most successful.

The central Pacific theater included the enemy's home islands and provided the most important test of the effectiveness of aerial mining. Mines were arriving in numbers at the forward areas, but the Navy did not have the planes to lay them in an all-at-once strike to paralyze enemy shipping and overwhelm any defenses. So **Ellis Johnson** (of the Navy, remember) went to **General LeMay** (of the Army Air Force) and persuaded him to supply bombers for a saturation attack. This move, made out of channels, reverberated through the Navy and many predicted dire consequences for **Johnson** (they should have given him a medal!)—but the deal went through. **Admiral Nimitz** furnished the mines, preparers, and training; **General LeMay** furnished **B-29s** and crews.

The minelaying program began on **March 27, 1945**, with 245 aircraft carrying 2030 mines, each mine having its own specific target on the map. Each mine was identified by five markings: type of firing mechanism, arming time, sensitivity, ship count, and date of sterilization. The prime objective was to block ship traffic in the home islands so that the enemy could not get raw materials and food, most of which came in from Asia. A second objective was to impound his navy so that it could not interfere with our landings on **Okinawa**, which were carried out almost simultaneously with the minelaying.

Victory at Last

The situation was right for success. The enemy no longer had air control over his islands, and his remaining navy was in anchorages whose exits were easily mined. The focus of his shipping, Shimonoseki Straits, was closed for about a month; this forced the Japanese to sortie a task force in an unprotected area. There it was seen by our reconnaissance, attacked, and sunk before it could sail for Okinawa.

We had learned a basic principle of warfare: if you have a new and powerful weapon, do not disclose it by fractions. Use it when you are prepared with devastating numbers. Hitler had made this mistake with his mines by the dozen.

As the mining progressed through the following months, ship traffic was shifted to other ports... which were also mined as soon as they became important. Those channels that were cleared (by sweeping or suicide boats) were remined. Export ports in Asia were also mined. By August, little enemy shipping was afloat and moving. Industry was slowing to a standstill. Food, scarce before, was getting scarcer. The enemy was militarily nearly helpless and would have surrendered, in time. But we did not have enough time, and his advisers convinced **President Truman** that a landing would have been very expensive in lives (Allied and Japanese). And so the war was ended with the nuclear bomb.

Some of Our People

I have mentioned various people specifically as the series continued. All were important in our work, of course. At great risk of leaving someone out who should not have been, a few specific personal sketches are in order.



Ellis A. Johnson.

There seems to be no doubt that one of the top heroes of NOL was Ellis Johnson. He was the first one outside the Navy to get involved in countermeasures to the magnetic mine threat, and drew into this work some of the ablest scientists to be involved, not only in countermeasures but in the subsequent work of the laboratory. Having gotten the R&D effort under way, he wisely turned his attention to the broader aspects of the problem. He saw that having a lead to an obviously powerful new weapon at the level of Commander would by no means assure that the high command in the Navy would use it. So he set about educating himself, and others, in the value of mining. Without his good judgment and bold moves, it is very likely that the 15,000 or so man-years that went into mine development would not have been used in World War II.

I have written of our first commander, **James Glennon**, and his stalwarts, **Robert Duncan** and **Ray Graumann**, on whom an avalanche of scientists and engineers descended,

starting in 1940. They withstood us well, never failing in their loyalty to the Navy whatever effect the incoming horde might have on their positions and occupations.

When **CAPT Walter Schindler** took over in 1943, we immediately took a considerable leap forward. Walt was recently back from having gone down (but not too far down) with the carrier *Yorktown* after the battle of Midway. He had been gunnery officer of *Yorktown* and had flown gunner in one of the attack planes to gain firsthand knowledge of what his flyers were up against. In fact, he is credited with downing a Zero from that action. With that background, CAPT Schindler was in a position to deal more effectively with the Bureau of Ordnance.

The desirability of a laboratory site separate from the Gun Factory became evident early. As we continued to grow in size and stature the need became pressing. Our "building committee" examined sites in the Washington area, and with the help of Navy Public Works we settled on the White Oak site as the most desirable. **Dick Dittmar**, who came to us from building management at Marshall Field in Chicago, helped us with this as he had with many of our workspace problems. After our building activities slowed he went on to big construction in Texas.

One of the distressing chores that fell to CAPT Schindler and me was to call on the two sisters who owned most of the land NOL took over. They had lived there most of their lives, and we had come to tell them that the Navy needed their land. Their home was what is now Quarters C. They were gracious about yielding their heritage to the needs of the Navy.

I have mentioned **Seymour Sindelband** before. After I had devoted



CAPT James B. Glennon, USN.

about a year to recruiting, I was shifted to mine development and Sindy was put in charge of recruiting, which he did very well. By another year there was a mine school in operation at Yorktown, but it concentrated initially on the moored mines of World War I; so we needed a "post-graduate mine school" at NOL to make sure that officers understood the new mines. Sindy seemed the logical one to start that school, and by early 1944 he had seen most of the officers who were running mine preparation stations in the Pacific. So CAPT Schindler got Sindy second priority orders to visit the three Pacific areas and gather firsthand knowledge of the problems that were being encountered with our weapons. Sindy went around the world on per diem; if that sounds glamorous, consider that the trip included participating in a minelaying expedition using three World War I four Pipers in very bad condition, passing within range of Japanese shore batteries. It also included visits to the mine supply facilities on Guadalcanal and Bougainville, which was venturesome business because of the number of Japanese still in the bushes. Then

"All these people, and their great accomplishments, had had their significant effect on the outcome of the war and produced a laboratory of great renown. But the war was over. It was time to decide what to do with the laboratory, and with R&D in the U.S. Navy."



Robert Duncan.

there was a lay across the Timor Sea, at extreme range for the PBY being used. On this expedition they put down a couple of Sindy's Mk 13s in the channel—and lost an engine. The engineer got it going again but it was leaking oil, probably from small arms fire. They got up to 20,000 feet when it finally failed completely, but it was enough to get over the mountains. They flew at 67 knots, just above stalling speed, for 10 hours, throwing out everything except life preservers. They got to Yampi, but there was not enough gasoline in the tank to smell! Eighteen hours on a B-24 loaded with gasoline, through Japanese-controlled territory, got him to India.

The rest of the journey was without incident, other than the little problem out of Burma when his plane limped back to base before the fourth engine stopped. Sindy's report was our first contact with the reality of the war, and with the important part our efforts were playing in its successful termination.

Inevitably my references to people are spotty and very incomplete. I have mentioned a few, while leaving out hundreds who did great deeds. It is of interest, for example, to note



Raymond L. Graumann.



CAPT Walter Schindler, USN, in the South Pacific (during improvised decorations in an impromptu ceremony).

that the inventor of the digital computer, **John Atanasoff**, and the co-inventor of the transistor, **John Bardeen**, both spent the war years at NOL.

All these people, and their great accomplishments, had had their significant effect on the outcome of the war and produced a laboratory of great renown. But the war was over. It was time to decide what to do with the laboratory, and with R&D in the U.S. Navy.



LT. S. J. Sindeband. Background: Guadalcanal jungle.

VI: A Laboratory in Transition

STEAM & SCIENCE IN THE NAVY

A couple of thousand years ago, oarsmen supplied the power to move ships, and some very successful battles were won with that power. Distances were short, as were the durations of the fights. As the battling world expanded, more effort was spent in harnessing the wind to move ships, and by that force most of the world was revealed to explorers. Yankee ingenuity, and the Clipper ships, got the speed up to the critical limit of "knots equal to the square root of the ship's length in feet" and beyond this speed, a ship could not be moved by sail.

John Fitch eventually built a steamboat, and Robert Fulton (who had capital, and obviously, the media on his side; many today think he invented the steamboat) built the first steam-powered fighting ship for our Navy. Like most weapons initiated after a war starts, Fulton's boat, *Demologos*, was not finished in time to participate in the War of 1812; however, it raised a significant question for the Navy. Sailors were sailors, not mechanics. Who will run the engines?

The question returned in March 1862, when *Monitor* came to the rescue of the wooden fleet in Hampton Roads. *Monitor* was an Ericsson design, constructed somewhat around rather than by the Navy, and required the President's support. Its engines were run by a civilian. There was not yet a Navy organization whose primary purpose was to

exploit advancing technology for the fleet.

But new problems provoke new solutions. There was sentiment in England to enter the Civil War on the side of the Confederacy, due to lack of cotton. The British heavies out-gunned anything we had, so the solution was to build a ship that could outrun their 14-knot capability. The Navy had a Chief Engineer by that time, named Isherwood. He designed *Wampanoag*, finished too late to take part in the war (where have we heard that before? Weren't we lucky to have had a head start of over a year on our mines?). In her trial run, *Wampanoag* averaged 17 knots for 24 hours. She was, in fact, so far ahead of her time that an examining board of wind-blown officers laid her up, and it was nearly 20 years before the Navy had another 17-knot ship. But Isherwood established an engineer corps, in an attempt to give a better status in the Navy to "the people who run the engines." The engineer corps lasted until nearly the end of the century.

When the National Academy of Sciences was formed during the Lincoln administration, about 20% of the membership was Navy-related. This would indicate that influential people in the Navy were recognizing the importance of science, and also that there were officers and others in Navy work who were accomplished enough in science to rate membership. As support of the Navy withered toward the end of the century, however, so did its strength in science and technology. By 1940 there was no

officer, or other member of the naval establishment, believed by the Academy to have achieved enough to be elected to membership. And the Naval Research Laboratory was by then 20 years old! Classification of much of the work was, of course, part of the problem; but it seemed to us that the Navy was not getting its share of the foremost thinkers in science and technology.

To answer "who will run the engines," the Navy had a class of restricted officers—the EDOs (see the 1 June issue of *OTS* for a story on Engineering Duty Officers). And during the war we managed to bring a lot of technical expertise into the laboratories (NRL, it turned out later, was a good step into radar, although not in time to get it into use before the British). How could we keep this expertise?

ADAPTING TO A NEW ENVIRONMENT

At about the same time, when it was becoming clear that we were winning the war, we began to think about the future of NOL: would it continue at something like its then-current size, shrink to its previous dimensions, or even disappear? The US had become the dominant world power, with greater responsibilities than ever before; but there was discussion of whether to abandon the White Oak enterprise, started but far from finished. The Russians were becoming more difficult, and this encouraged caution. ADM Willard Kitts, in the Bureau, made a strong plea for finishing the plant, because it would give a



RADM Willard A. Kitts, III, USN.

big boost to keeping such of our good staff as was needed, together. The emergence of the Cold War confirmed the wisdom of this decision; NOL was continued and, as I remember, the population never fell below about 2200.

By this time we had been folded into the Civil Service system in a snowstorm of job-description paperwork (so much of it fiction!), and nearly everybody got a raise. With at least some continuity assured, we were faced with the problem of learning to run an effective R&D organization without the stimulus of a national emergency. We had to retain as many of our good thinkers as possible. This meant status for technical people working in a military establishment where status was so important that you wore it on your sleeve. The Navy had ensigns, lieutenants in two sizes, commanders in two sizes, captains, admirals in three sizes with another to be added, and an occasional commodore; but civilians seemed to come in only one size.

The first step was an all-civilian technical organization, which we had already achieved; this would have been more difficult in any of the other Bureaus. By the nature of this organization, the technical leader dealt with the officer-in-charge, and if military people entered the organization they were advisers unless so assigned because of their technical qualifications. We were lucky to have superior officers, returning from the Pacific, assigned as advisers to our technical sections. They made important contributions as experienced users, and most made admiral when their time came.

Next, the technical leader was given a distinguishing title: Technical Director. This was made easier because at the start the senior technical man at NOL was in military rank equal to the officer-in-charge. **Dr. Duncan** suggested the term Technical Director, and it has been accepted almost universally in the Navy's laboratories. The title "Doctor," by the way, was of course common in the Lab but had little ranking significance.

Next, the Technical Director began having the same perquisites as the OIC. When quarters "A" were built for the CO, Quarters "B" were built for the TD. Note, too, that the designation for the military head went from OIC to CO in 1946. Present for the change was **Fred Withington**, perhaps the most intellectual of our commanders. He stood high in his class at Annapolis and knew a great deal about the technology of ordnance. He had a good understanding of what we were doing and provided a good connection to BuOrd and the rest of the Navy. He also knew how to be a sailor; I once went with him on a short cruise aboard *Mississippi* and observed his skill at seamanship.* CAPT Withington was a strong supporter of NOL policy, evolved through expensive experience, of requiring an independent evaluation



CAPT Frederic S. Withington, USN.

of our products, and a separate organization to do it, before the designs went to production.

With the war ended, **Admiral George Hussey** (Chief of BuOrd) was faced with the problem of keeping his two most senior technical leaders on the job: **Thompson** at China Lake and **Bennett** at NOL. He went to Congress and got Public Law 313 passed, which in time led to the super-grade system. His plan called for 15 positions, five each for the Army, Navy and emerging Air Force. Outside business was picking up, and opportunities were appearing which made the top Civil Service pay (\$10,000) look unattractive. Thompson and I were appointed, and soon

*We met and saluted a British cruiser with the right number of bangs in the right sequence, which impressed me. So did the way he brought *Mississippi* into the right anchorage in the confined waters of Hampton Roads; he had two groups sighting church steeples and lighthouses, plus sounders going, to make sure he really knew where he was. I recalled this performance later on, when *Missouri* ran into our sound range, high and dry, while the skipper was having coffee in the wardroom.



ADM George F. Hussey, Jr. USN.

moved to the new top salary: \$15,000. So I took off my sailor suit and stayed in the same job—for seven more years.

A MATURING ORGANIZATION

It was an important time for the laboratory, which had grown from so little in just seven years: the super-grade change, a civilian TD, and a new environment. The complex at White Oak, begun years earlier (the cornerstone was laid in 1946), was nearing completion and our people were moving out one section at a time. In addition, we had our first CO of flag rank: **RADM Frank Beatty** (during his incumbency, the designation was changed again, from CO to Commander). Frank was a helpful fellow who got acquainted with the local politicians—for example, President “Curly” Boyd of the University of Maryland, helping us develop the cordial relationship with that institution which I believe still exists. I used to have a little trouble getting the senior people to live up to the rules they made for all of us, and Frank was sometimes a little hard to handle. He once told one of my acquaintances that he thought I could see cumshaw in a closed desk drawer.**

With the help of Admiral Beatty and the concurrence of the Chief of BuOrd, we set up an Advisory Board to guide us in our attempts to run a productive organization. We thought it advisable to select persons who had actually managed R&D successfully.

Mervin Kelley, President of Bell Labs, was the first chairman. Other members were **Guy Suits**, VP Research for GE; **Gaylord Harnwell**, President of the University of Penn-



RADM Frank E. Beatty, USN.

**Admiral Beatty kept ducks at Quarters A. However, he was hard of hearing; and when he was succeeded by Admiral Hanlon, the new commander disposed of the little darlings immediately because of the noise they made welcoming the dawn. He gave them to us, and Mrs. B., after an unpleasant massacre in the woods, concocted a dish she christened “Duck Admiral” and served it to the next meeting of a National Research Council committee that convened at our house.

sylvania, who during the war had run the Navy’s electronics laboratory at San Diego; and **John Sachs**, retired from directing chemical research at DuPont. The group met every few months and helped us in many ways.

During the war, speed was more important than cost, although at times we achieved neither speed nor economy. As the war ended we recognized that we could be more efficient, and took steps to become so. **Cliff Livermore**, with the help of **Bob Stotz** and **Fletch Byrum**, were important in this part of the organization. By the time of my last years at NOL we had a budget of about \$100 million,** suitably broken down into various categories. We reviewed this budget monthly and tried to develop cost-consciousness on the part of the entire staff, recognizing that we were spending taxpayer money that had been entrusted to us. At that time we were spending about \$3.50 a second around the clock. I was much surprised to learn, when I entered industry, that we had a far more lively concern for the taxpayer’s money than did industrial people!

As we grew in stature, we were noticed by others in “the establishment.” Occasionally we would get a request from another Navy enterprise for, say, a Technical Director. I always told the requester to help himself, and offered to give whatever information we had on any likely candidate. We supplied a few TDs, and the morale of our people was the better for it.

We were also noticed by the neighbors at White Oak, of course. Late comers or early leavers were conspicuous by their entrance or exit at the one gate we used, and we liked to give the impression of being punctual. For most of us, the amount of work we did was related to the time we spent at

***The total NSWC budget for FY84 is \$510.4 million. The magic million-dollar-a-day mark (\$365 million annually) was reached in 1976.



RADM Frank E. Beatty, USN, followed by Fleet Admiral Chester Nimitz, USN, and party, leads the way from one of the NOL wind-tunnel buildings during an inspection tour in October 1947. Navy admirals traveled well in those days: the car is a 1942 Packard One Sixty limousine with 2-way radio.

it; so being on time was only honest. But we had some workaholics too, people who worked all the time, so for those in this group who neither had to set a good example for the young, nor supervise anyone, we made exceptions.

Our neighbors were tolerant of our presence for the most part, even though we snarled the traffic on their quiet, rural, two-lane Avenel-White Oak Road—later renamed New Hampshire Avenue—for about two hours a day. And Paul Fye's banging in his bomb-proofs in the back yard finally had to be limited or muffled.

We tried, by regular meetings of department heads, to keep all members of the staff informed of what was going on. The department

heads in turn had meetings of division heads and so on down to all hands. We also instituted the annual meeting of the professional staff and supervisors on the last working hour of the year. In it, the Technical Director reviewed the accomplishments of the year and the plans for the new year. We realized that we were of the Navy; that the Navy was our first line of defense; and that the ordnance, of which we were an important part, was what gave the Navy its power. At year's end we usually had important accomplishments to review, accomplishments of which we could be proud. I understand that this custom of a year-end meeting has been copied elsewhere, and has also been elaborated upon. We found it a useful way

"By this time we had been folded into the Civil Service system in a snowstorm of job-description paperwork (so much of it fiction!), and nearly everybody got a raise. With at least some continuity assured, we were faced with the problem of learning to run an effective R&D organization without the stimulus of a national emergency. We had to retain as many of our good thinkers as possible."



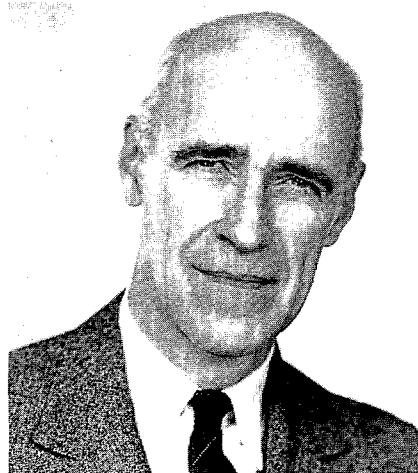
to enter New Year's Eve; and it even had the useful side benefit of providing a reason for all hands to stay on the job until close of business that day.

POSTSCRIPT

I have found much pleasure in putting this story together, and in the process have revived many pleasant memories. One thing I am reminded of, and for which I am very grateful, is that so far as I know all of us survived the war. This was a fortunate achievement, considering that so many of us were in dangerous circumstances much of the time. It has been difficult to do this series well, because classifi-

cation prevented my taking any records when I left. So much of the story comes from memory, with an appreciated assist from many at White Oak who have provided a connection with the records, and sent me some of them now that they are declassified.

The appearance of earlier installments of the series has also generated some "fan" letters, which contain interesting facts that I had forgotten or never knew. I am sending those to the library for preservation. Thank you all.



CAPT Ralph D. Bennett, USNR.

Epilog

Our series on the Bennett Years concludes with this installment. Many have written or called to tell us how much they have enjoyed this series. A typical response is the one from **Dr. Newell Gingrich**, Professor Emeritus of Physics at the University of Missouri in Columbia, who joined the staff in 1941. "Was it ever a desert down there," he says today. "The building in which I started to work was old and about as bare as Mother Hubbard's cupboard. Requisition procedures were unbelievably cumbersome, though an expensive item was as easy to obtain as a trivial one." Dr. Gingrich's experiences, too lengthy to relate here, include one that many will relate to: in 1942 he made many calculations for gradiometer coils, and recorded his work in NOLR 653. "Some time after publication... of my report... a security guard came with a drawn gun to my desk demanding that I give him (everything) having to do with NOLR 653... later I learned NOLR 653 was classified SECRET and I was cleared only for CONFIDEN-

TIAL."

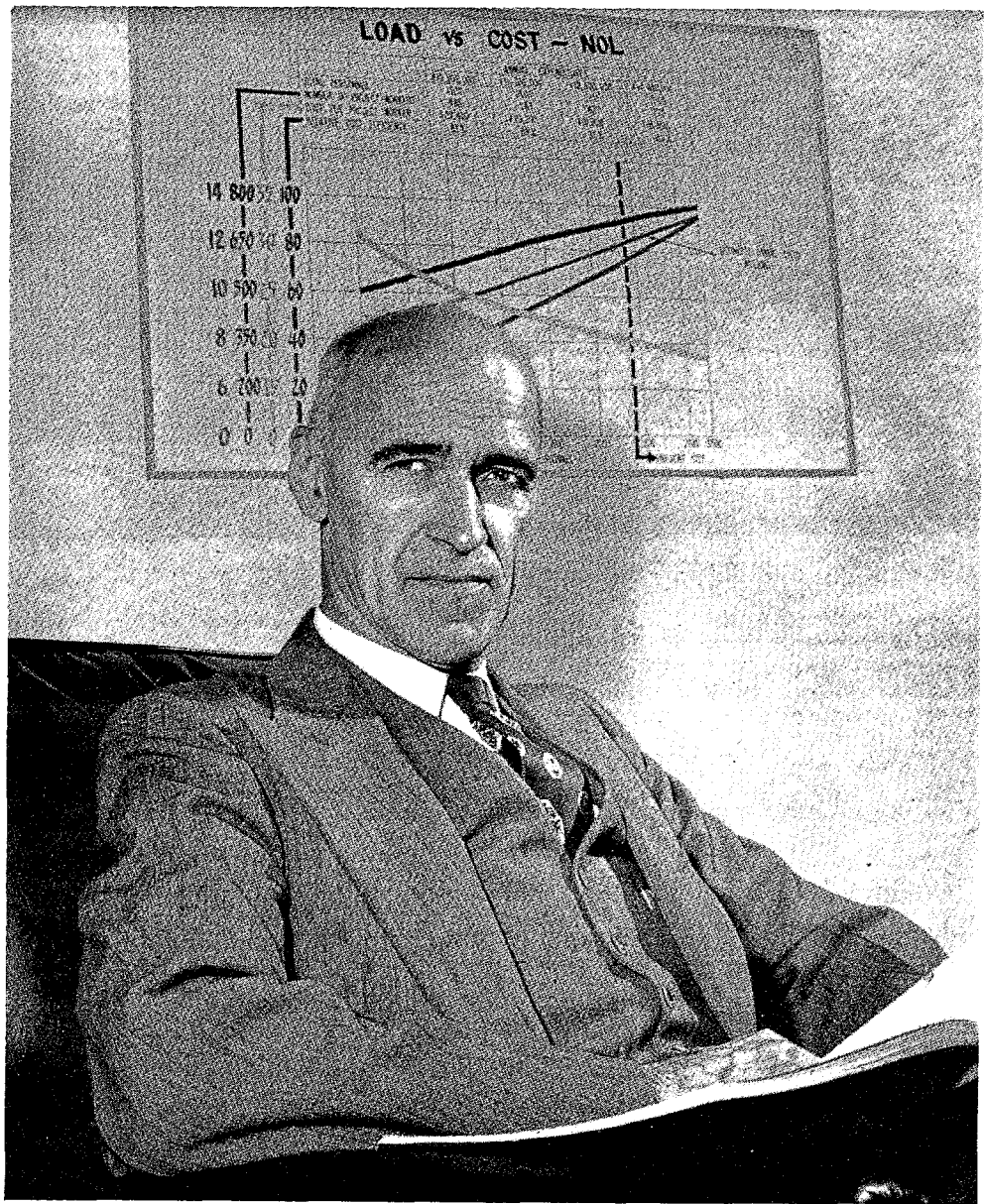
As for the author of the series, he keeps busy. He has been associated with Union College (Schenectady, N.Y.) since 1917 when he was an entering freshman, and became a trustee in 1946. He holds an honorary degree for his accomplishments for the Navy and missed only two trustee meetings in 33 years as an active trustee; his experiences were set down in a publication entitled "400,000 miles for Alma Mater." He chaired a committee on academic affairs before retiring as an active trustee. "I'm emeritus now," he says with a twinkle. "But I'm the only one who's raising any hell about engineering."

Following his tenure at White Oak, Dr. Bennett served on the Ordnance Advisory Board for approximately three years. This Board visited the various laboratories as disinterested outsiders with unusual expertise.

Since his retirement from General Electric and Martin/Martin-Marietta ("they found out how old I was"), he has kept busy. When he

is not writing for *OTS*, Dr. Bennett works with his wife Anna "in the dungeons of the DeYoung Museum, one of the Fine Arts Museums of San Francisco." This work consists of "organizing, storing, exhibiting, and showing the items in the textile collections." And there are other activities that take up the time. "Don't retire," he advises. "It's too hard work!"

We hope that this series of articles has been as interesting and useful to all the readership as it has been for us. Given that this is the Center's 10th anniversary year, we are planning a few more pieces on those who were important to its past. However, perhaps none was more important than the ex-academic, Ralph Bennett. "I am pleased that you are writing up the history of your NOL work," says Dr. Gingrich. "To anyone who knew about the tremendous losses we suffered because of the German submarines, the work you did must stand out as exceedingly important and effective." We can think of nothing we would want to add to that.



DR. RALPH D. BENNETT

